Digital Twin Center of Excellence Concept: Collaboration and Workforce Development Thrust

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Outline

- Summary of Digital Twin COE Collaboration Thrust
- Challenges in Higher Ed to Support Digital Engineering
- Digital Twin-Focused Industry-Academic Partnerships

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Summary of Digital Twin COE Collaboration Thrust

Thrust Summary

Whitepaper Team: Shawn Midlam-Mohler (Ohio State University), Frank Ciarallo (Air Force Institute of Technology), Neil Littell (Ohio University), Andrew Shepherd (Sinclair College), David Koukol (University of Dayton), Nate Hartman/Dan DeLaurentis (Purdue University), Scott Petersen (University of Cincinnati), and Madhavi Kadakia (Wright State University)

Approach:

- **Talked with proxies for the Air Force customer**
- **Requested capabilities matrices from partner institutions**
- **Developed whitepaper and passed draft to partners**
- **Integrated feedback and passed on final version to ARCTOS**

Proposed a **Digital Twin Center of Excellence** to develop:

1. Digital Twin Processes: Well-understood digital twin techniques to meet Air Force needs more effectively than current approaches
2. Digital Twin Competencies: People that have the requisite training and education to execute the digital twin processes
3. Digital Twin Infrastructure: IT infrastructure to support the needs of the people and process

University of Dayton

PURDUE UNIVERSITY

University of CINCINNATI

THE OHIO STATE UNIVERSITY

SINCLAIR COLLEGE

AFIT AIR FORCE INSTITUTE OF TECHNOLOGY

WRIGHT STATE UNIVERSITY

OHIO UNIVERSITY

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Digital Twin Growth in Industry

A common pattern exists for how initial Digital Twin techniques mature in industry:

- Grass Roots Growth: Resource constrained areas with needs innovate methods to stay above workload
  - *e.g.,* Destructive testing of large assemblies

Senses Needs / ROI

- Connect the Dots: Initial successes grow Into adjacent areas organically
  - *e.g.,* Sharing models upstream and downstream to share development burden (and help other groups…)

Defines Tools

- Critical Mass: The organization recognizes value and creates top-down policy/process/infrastructure
  - *e.g.,* PLM Software

Builds Infrastructure

- Carrot/Stick: Once the process exists, adoption can be tough…
  - *e.g.,* Development vehicle budget reductions in automotive

Encourages Adoption

Process Overview – 1/3

The vision of the proposed process is to catalyze digital twin capability in a manner that is consistent with how it has often organically grown in Industry:

1) Identify Air Force Digital Twin Needs
2) Evaluate Proposals by a Digital Twin Incubator Steering Committee
3) Develop Proposals to Meet Air Force Digital Twin Needs
4) Select Proposals to Maximize Impact
5) Assessment of Projects Against Air Force Needs

The goal of this process is to:

1) Guide investment in process development, training, and infrastructure in the areas that are strategically and culturally ripe for digital twin
2) Guide the adoption of the tool up and down the system engineering phases of the project
3) Guide the adoption of the tool into other programs

Process Overview – 2/3

The process would use the following to allocate project funding:

1) Identify Air Force Digital Twin Needs: To be relevant, ideas need to be sourced from within the Air Force itself. To be maximally forward looking, additional ideas need to be sourced from organizations outside of the Air Force. These project concepts are captured and moved forward to the Digital Twin Incubator Steering Committee.

2) Evaluate Proposals by Digital Twin Incubator Steering Committee: The project ideas are evaluated by the Digital Twin Incubator Steering Committee and high-potential, high-impact ideas are presented to the larger Digital Twin Incubator Team. The Digital Twin Incubator Steering Committee will select concepts to move forward which best meet Air Force needs, as well as provide overall strategic value to the overall goal of a comprehensive digital twin process.

3) Develop Proposals to Meet Air Force Digital Twin Needs: For each Air Force requirement, the project specific team develops collaborative proposals with the Air Force customer to address the concepts from the previous step. These are refined through an iterative process and finalized in a formal proposal that returns to the Digital Twin Incubator Steering Committee for review and to the Air Force customer for approval and funding.

Process Overview – 3/3

4) Select Proposals to Maximize Impact: The Digital Twin Incubator Steering Committee reviews the proposals and selects those that provide the most impact to the overall Digital Engineering strategy of the Air Force. These may be selected as high-risk, high-reward projects or be very process-driven to solve a near-term need. The DTI Steering Committee will balance the portfolio of recommended projects based on feedback from the Air Force customer.

5) Assessment of Projects Against Air Force Needs: Projects funded through this effort will be formally reviewed against milestones by the Digital Twin Incubator Steering Committee and appropriate Air Force customers. This will ensure high-quality results and that project team is identified and aligned. Each specific project funded will have a dedicated project manager and be planned and conducted as a project as opposed to a classical university grant.

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Challenges in Higher Ed to Support Digital Engineering

Challenges to Producing DT Research

- Faculty Awareness of Digital Twin: Faculty are often not highly aware of terms like Digital Engineering, Digital Twin, and Digital Thread despite working in these areas
  - *e.g.,* OSU general call for DE expertise
- Institutional Priorities for Focusing on Applications of Process/Tools: Academia tends to be more focused on basic research and applied research in topic areas
- Bridging Gap into DoD Application Areas: Transitioning faculty into DoD-centric work is possible but requires TLC
  - *e.g.,* Transitioning my own activities into DoD
- Handling the Security Needs of Some DoD Project Needs: This depends greatly on the individual institution

AFSIM

Challenges to Producing Digital Twin Talent

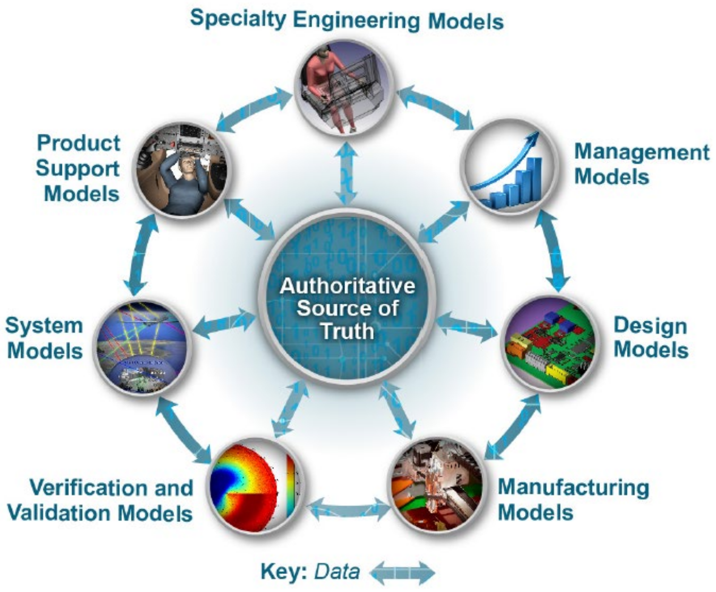
- Student Awareness of Digital Twin: On-Campus students are not aware of the concept of modeling, simulation, or digital twin
  - *e.g.*, SimClub Experience

- Curriculum Density in Four-Year Programs: Digital Twin content is typically not part of core curriculum and only get a few technical electives to choose from

- Challenges Retaining Domestic Students for Grad Work: The allure of the job market is strong, pulling students out prior to having intensive Digital Twin training

- Competitive Hiring Market / Undersupply of Talent: Hard for organizations to get limited students that already have Digital Twin experience

- Balancing Skill-Based Training and Knowledge-Based Training: Access to appropriate training to build tool skills but also how to properly use them



DEPARTMENT OF DEFENSE
DIGITAL ENGINEERING STRATEGY
JUNE 2018

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Digital Twin-Focused Industry-Academic Partnerships

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Seminar Series on Industry-Academic Partnerships in Modeling and Simulation

Academia & Industry Collaboration: Preparing Students for Careers in Engineering Simulation

The future of the engineering simulation workforce is dependent on two essential elements: strength of the academic curricula & instruction, and industry engagement in those educational programs. In this NAFEMS webinar series, modern teaching and educational methods will be highlighted as used by academia in addressing the rapid advancements in engineering simulation techniques for students, both undergraduate and graduate, who are seeking careers across all technical domains and industries. Attention will be given to how and why industry/academia collaborative efforts are becoming significant factors in taking college-level educational environments to new plateaus.

Three webinars are included in this series, which will highlight collaboration between the following:

- University of Cincinnati Simulation Center & Procter & Gamble (December 8th, 2021)
- Aerospace Systems Design Laboratory, Georgia Institute of Technology (April 8th, 2022)
- The Ohio State University SIMCenter & Honda (July 21st, 2022)

Videos and slides available after you create a free NAFEMS login

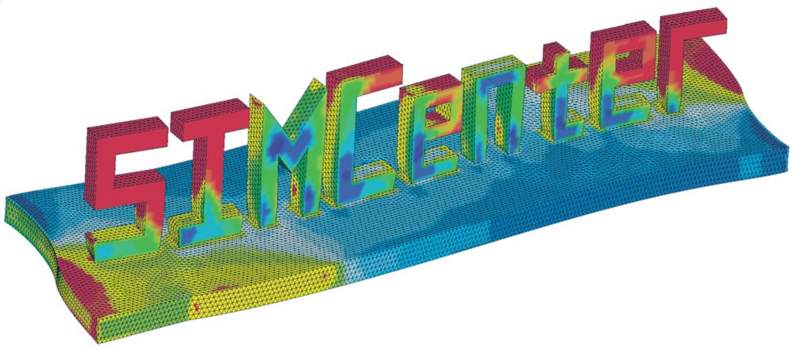
Shortened Link to OSU webinar: https://go.osu.edu/nafems

Abridged version will be presented today

SIMCenter 1.0 Overview

Overall Mission:

- To advance computer-aided engineering techniques in research, product development, and manufacturing
- To be a catalyst for innovation in simulation technology, through collaborative, interdisciplinary research
- Develop students and professionals with CAE skills



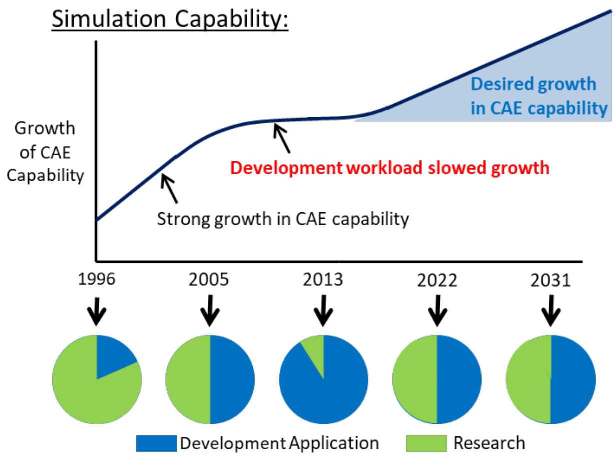
SIMCenter was initiated as a joint effort between HRA and the College of Engineering in 2014.

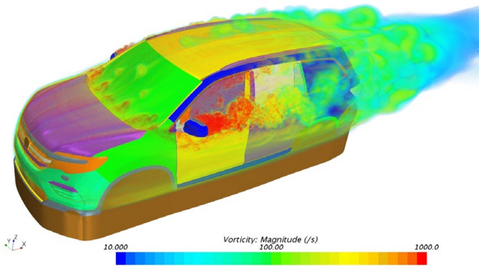
Key Activities:

1. Develop new modeling and simulation methods (**basic research**)
2. Mature methods through solution of sponsor problems (**applied research**)
3. Transfer results and methods into the sponsor's organization (**technology transfer**)
4. Support sponsor adoption through professional development and education of students with improved M&S capabilities (**education**)

Motivation for Honda's Research Collaboration with OSU

- Regular CAE application for automotive development was very limited in the mid-1990s. Many applications taken for granted today were still under development.
- Due to great successes, by 2005 many associates who had been developing more advanced CAE applications were now spending most of their time applying these methods to product development.
- By 2010 this situation combined with the complexity needed in future capability was restricting needed growth in CAE methods.
- We were asking ourselves "How can we continue to most effectively develop these methods which are key to providing reduced development cost and time, while providing potential product design enhancements?"



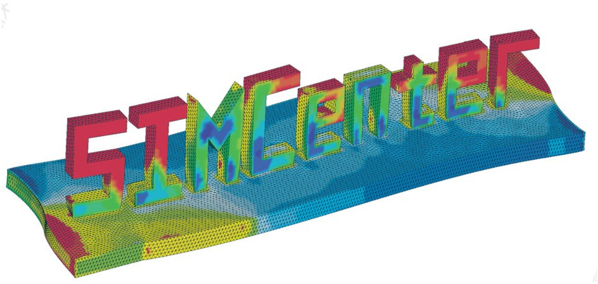


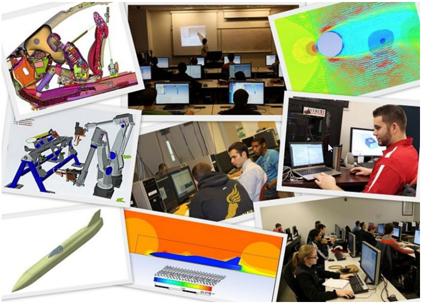
SIMCenter Origin

We needed a partner to conduct CAE research with to produce innovative development applications of modeling and simulation …

In 2013 HRA decided we needed to partner with The Ohio State University to establish and maintain the OSU **Simulation Innovation and Modeling Center** or **SIMCenter** with the combined visions between HRA and OSU:

- Produce innovative developments in computational engineering methods.
- Become a world leader in the application of computational engineering techniques.
- Provide support for undergraduate students, graduate students, research staff, and faculty.





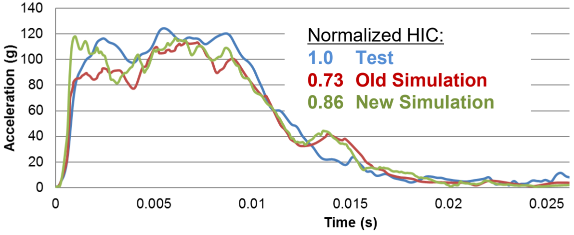
SIMCenter – A simulation and modeling research center at OSU to develop world leading technology for Industry

Research Examples

<u>Initial Projects were Generally in 2 Categories</u>:

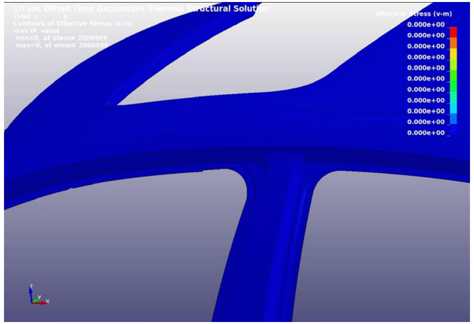
- Enhancements to established methods from unique university capabilities :

  Example: Dynamic friction testing and modeling for crashworthiness simulations



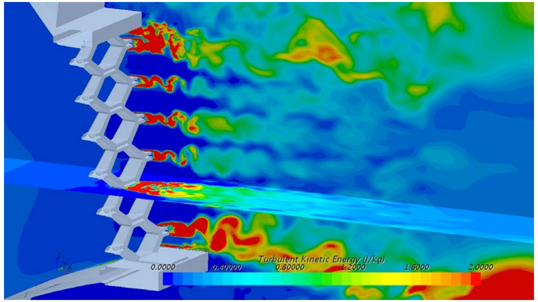
- Development of complex multi-physics models and/or coupled simulations:

Example: Thermal Deform Prediction



Example: EM with Structure Influence on Antenna Performance

Example: Aero-acoustics Predictions



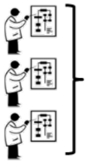
Formation of the SIMCenter

CAE Methods Needs and Seeds for Research Projects

Technical Expertise, Know-how, and Man-Power

OSU SIMCenter:

- Faculty with industry research experience.
- Access to industry CAE software suite.
- CAE application experts on staff who have experience in commercial CAE software.
- Access to the Ohio Super Computing HPC.
- Distance learning CAE certificate program.



Honda Project Advisors

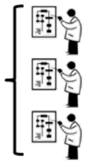
Honda

Advancement in CAE Techniques

New/Improved CAE Models

New Modeling Methods

Algorithms and Basic Modeling Methods → Implementation in commercial software → Validation by Practical Applications



OSU Faculty Advisors (BS, Ms, PhD Students)

OSU

Student Experience

MS & PhD Research Projects

Publicity to attract great staff & students

Governance:
Mutually agreed upon KPI's which increased every year for the first 5 years to guide growth & measure success

Restults:
SIMCenter grew in 5 years to +20 active Honda projects

With +15 new CAE methods in development application

SIMCenter grew quickly and become a success in helping achieve CAE goals

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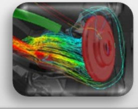
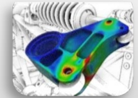
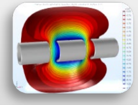
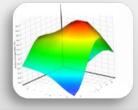
SIMULATION INNOVATION AND MODELING CENTER

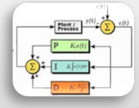
SIMCenter 1.0 Thrust Areas

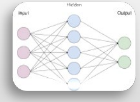
Computational Fluid Mechanics


Computational Solid Mechanics


Multi-Physics Simulation


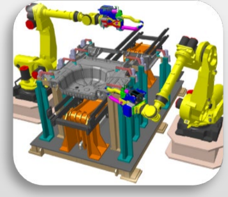
Optimization & CAE Automation


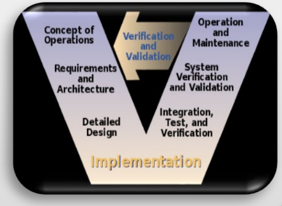
System Modeling, Integration, and Controls


Non-Physics, Data-Driven Models


Six Thrust Areas

Product Development


Manufacturing System/Process Development


Systems Engineering


Three Product Processes


Automotive


Whitegoods

• • •


Aerospace

Many Application Areas

Strong Sponsor Relationships

HERCULES® Since 1902

GM

DSO NATIONAL LABORATORIES

THE PERDUCO GROUP A LINQUEST COMPANY

TWB

SCHAEFFLER GROUP AUTOMOTIVE

NSF

alift®

GE Aviation

US TECHNOLOGY CORPORATION

MOTOR HARLEY-DAVIDSON COMPANY®

GREIF®

U.S. DEPARTMENT OF ENERGY

HONDA

Honda R&D Americas

Scientific Forming Technologies Corporation

AIR FORCE RESEARCH LABORATORY

ANSYS®

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engie

FCA FIAT CHRYSLER AUTOMOBILES

DEPARTMENT OF TRANSPORTATION UNITED STATES OF AMERICA

GE APPLIANCES a Haier company

TOYOTA

UTC

NINESIGMA® Accelerating the Innovation Cycle

FEDERAL AVIATION ADMINISTRATION

NASA

OAK RIDGE National Laboratory

TENNECO Automotive

Ford

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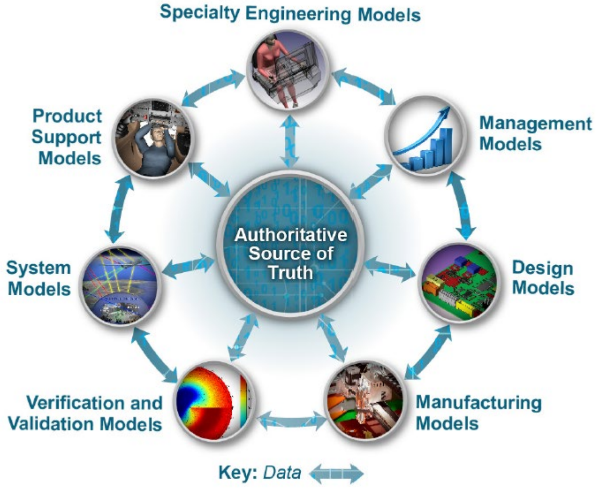
Next Steps

- We have a strong collection of academic institutions at the ready to support Digital Engineering activities in the area
- We have examples of successful academic-industry-government partnerships as models of engagement
- We are looking for a need to rally around to support the growth of the regions digital engineering capability



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